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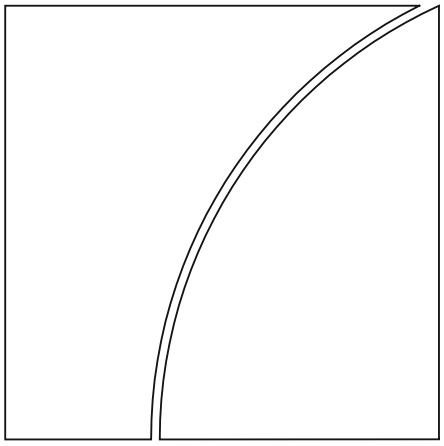

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Keywords: Low inflation, ageing economy, Phillips curve

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Can an ageing workforce explain low inflation?*

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Abstract

Why is wage inflation so weak in spite of the recent sharp reduction in unemployment? We show that this may be due to an ongoing change in the composition of the labor supply. Indeed, the participation rate of workers aged between 55 and 64 has increased steadily over the last decade, from a third to above a half on average across OECD countries. This is most likely the consequence of ageing and the reform of pensions. We show that the participation rate of workers aged 55 to 64 contributes to explain why wage inflation has remained weak over the last five years. Our second result is that Phillips curves are alive and well. When exploiting the cross-country variance of the data, wage inflation remains highly responsive to domestic unemployment rates, including after the Great Recession.

Keywords: Low inflation, ageing economy, Phillips curve.

JEL codes: E5, J3

*This paper reflects the views of the authors and not necessarily the views of Bank of International Settlements, Banque de France or the Eurosystem.

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1 Introduction

We investigate the effects of ageing on inflation through the labor market. More specifically we test whether the weakness of wage inflation over the last five years reflects, at least partially, the increase of labor supply by baby-boomers. [1]

The post 2013 recovery of advanced economies has not yet translated into "normal" levels of inflation. Core inflation remains near 1% in the euro area, it has increased from zero to 1% in Japan, while in the US it approaches 2% after a sustained recovery. Most other advanced economies see little inflation either. Core CPI inflation, the GDP deflator inflation and wage inflation adjusted for productivity have all remained closer to 1 % than to 2%, their pre-crisis nominal anchor (see Figure 1, in IMF 2017 and Constancio 2017). In the case of the euro area, we observe lowflation in spite of the creation of over 9 million jobs and over 20 quarters in a row of growth at or above the euro area 1.2 to 1.3 % yoy growth potential.

As shown in Figure 2, unemployment has also declined steadily from its peak by several percentage points in the US, Japan, Germany, Canada, the UK and Spain. Yet inflation is hardly picking up in these countries. It is very tempting to conclude that the traditional Phillips curve may be broken for good[2], which in turn questions whether and how central banks can control inflation. [3]

Another well-known major transformation of advanced economies is the ageing of baby-boomers, i.e. cohorts born between 1945 and 1968, i.e. people now aged between 50 and 75 (Cahuc at al. 2016). What is much less known is the tremendous increase in the participation of these baby boomers to the work force. For instance, 6 of the 7 million jobs created in the euro area between 2013 and 2017 were above 50. In the US, the share of workers above 55 in the workforce has almost doubled from 12 % in 1995 to 23% in 2016. In Japan, even the participation of workers above 65 has increased by nearly 4 million since 2007. The participation rates of workers aged 55 to 64 has increased from 33% to 55%, on average across OECD countries in the last decade (Figure 3). In Germany it increased from around 40% until 2003 to above 70% in 2016. This major transformation of the work force coincides with the setting up of pension

[1] Several papers have analyzed the relation between ageing and inflation. See for instance Bobeica, Lis, Nickel, and Sun (2017) and references therein. However, to the best of our knowledge, none have stressed the role of labor supply of elderly workers. On the effects of ageing on asset prices see also Takats (2010).

[2] The weakening of the effects of domestic activity on domestic inflation could result from the growing importance of global value chains (see Auer et al. 2017 and references therein).

[3] For a recent overviews of this debate see Blanchard (2017) and Blanchard, Cerutti, and Summers (2015) , Auer, Borio, and Filardo (2017), Ciccarelli and Osbat (2017) as well as the IMF WEO (2015, 2017) and Ciccarelli and Osbat (2017) and Martina, Moessner, and Takáts (2018)The Economist, (1 nov. 2017)

reforms that became implemented as baby-boomers cohorts approached the age of retirement. As shown in for instance in Schmieder, Von Wachter, and Bender (2012) and in Schwandt and Von Wachter (2017) such demographic conditions may influence the determination of wages drastically.

In principle, this increase in participation may however also reflect an increase in labor demand, in which case we expect it would have pushed wages up. The fact of the matter is that, as we show in this paper, wages have responded negatively to increased participation of older workers. Therefore, the change in the composition of the workforce is akin to a major labor supply shock by ageing workers. Most likely these aim to preserve their lifetime purchasing power through postponing their retirement. Ceteris paribus, this positive labor supply shock is likely to push down wages and unit labor costs. If this transition implies a level shift over several years, it may also impact wage inflation during the years when the transition is taking place. Our empirical analysis shows that this conjecture cannot be rejected. Our estimates indicate the participation of the elderly has a specific effect on the labor market. It is different than the one of other age groups. A plausible explanation is that, as Hairault, Langot, and Sopraseuth (2014) note, the shorter time-horizon of job tenures reduce the outside value of the elderly. Hence they have less incentive to search for other jobs. As a result, the increase of the participation of the elderly workers may decrease wage pressure[4]. The Bank of Japan (2018) shows that the wage elasticity of labor supply for elderly is twice as high as the one of men aged 15 to 64, which contributes to explain why Japanese wages have stagnated in spite of the steady decline of the unemployment rate. This overall negative effect is consistent with our estimates.

Our second result is that wage Phillips curve find very strong support both in country and region panels. Looking either across each of our three panels of countries (the G7, 8 EA member states or 19 OECD countries) or a panel of 203 European regions we find that, in the last two decades, wages respond negatively to unemployment. The response to unemployment is highly significant both statistically and economically. Henceforth, wage inflation still responds strongly to (measures of) labor market slack. A one percent decline in the unemployment rate increases wage inflation by 0.5-0.6% on average in the G7 panel, 0.4% for the OECD panel and 0.25% in the 8 EA member states panel. Post 2009, this effect is slightly lower (0.3) for either the G7 or OECD wide panels but it is stable in the panel of euro area countries. This strong Phillips curve pattern also characterizes regional data in Europe.

[4]See also Agbayani, Gasperini, Moore, Nanda, Patterson, and Wander (2016), who provide an extensive literature review about the many dimensions along which older households differ.

2 Wage dynamics in an ageing economy : decomposing the effect

In this section we use a simple model to decompose the channels from an an increase in the participation of old workers to the aggreate wage. This decomposition allow us to outline the effects presented in the literature and the roles of level and growth effects. To put it in a nutshell, the ageing population by itself does not generate a downward trend in wages. However, higher participation rate of old workers who move to well-paid job to jobs with lower wages pushes down the aggregate wage.

Following the literature, we assume that there are three types of workers: the young, the old with continuous careers and the old with discontinuous careers. Old workers of period t, who were young in period t-1 can, either stay in their job, i.e. they have a continuous career, or become « workers with discontinuous jobs », i.e. they switch from being employed to being unemployed frequently, or they don't participate to the labor market.

Each period there are N_t young workers, growing at a rate $g_t = (N_t - N_{t-1})/N_{t-1}$. The total population is thus $N_t + N_{t-1}$.

To simplify and given our focus on ageing workers, we assume that all young workers work. In contrast, old workers can be in three states. A fraction c_t work and experience a continuous career. A fraction d_t work but experience a discontinuous career, typically switching from non-participating to participating activities. A fraction n_t doesn't work, being either unemployed or non-participating in the labor market.

The working population is therefore

$$L_t = N_t + c_t N_{t-1} + d_t N_{t-1}$$

Labor demand is captured by an index x_t which is positively correlated with economic activity. We assume that each of the three types of workers has a specific wage level and a specific labor supply elasticity. The wage of each category depends positively on labor demand ad negatively on the labor supply of other categories of workers.

In period t, the wage of young workers is w^y ; the wage of old workers with a continuous career is w^c and the wage of old workers with a discontinuous career is w^d. These wages may be a function of the labor supplies and demand, and of the state of the business cycle denoted by x. We skip these dependancies to ease the exposition.

The average wage in this economy is

$$w_t^m = \frac{N_t w^y + c_t N_{t-1} w^c + d_t N_{t-1} w^d}{L_t}$$

After some direct algebra, the average wage in the economy can be written as $w_t^m = \omega_t^y w^y + \omega_t^c w^c + \omega_t^d w^d$, where

$$\omega_t^y = \frac{1+g_t}{1+g_t+c_t+d_t}; \omega_t^c = \frac{c_t}{1+g_t+c_t+d_t}; \omega_t^d = \frac{d_t}{1+g_t+c_t+d_t}$$

and $\omega_t^y + \omega_t^c + \omega_t^d = 1$

Let us review some of the main stylized facts that stand out in the literature on the effects of demographics of labor markets (see Casanova (2013), Agbayani, Gasperini, Moore, Nanda, Patterson, and Wander (2016) and references therein).

1. The average wage of old workers is higher than the wage of young workers

$$w^y \leq \frac{\omega_t^c w^c + \omega_t^d w^d}{\omega_t^c + \omega_t^d}$$

in the US for instance, the wage profile by age is an inverted U-curve in most countries (Luke and Duell (2017)), the average wage of old workers is higher than the wage of young workers due to an increasing average wage profile until 50 years old (See for instance Hairault, Langot, and Sopraseuth (2014)). However, the average wage increase of workers aged over 55 has been consistently 1 percent below the one of the entire workforce since 1996 (National Bank of Canada (2017)).

2. The wage of old workers with discontinuous career is lower than the average wage.

$$w^d \leq w_t^m$$

3. The average wage of a young worker is more responsive to the business cycle than the average wage of old workers[5].

$$\frac{\partial w^y}{\partial x} \leq \frac{\omega_t^c \frac{\partial w^c}{\partial x} + \omega_t^d \frac{\partial w^d}{\partial x}}{\omega_t^c + \omega_t^d}$$

4. The effect of economic activity on wages of old continuous-career workers is lower than

[5]The Bank of Japan (2018) reports evidence that the labor supply of older workers (65 and above) is twice elastic to wages than the one of workers aged 15 to 64, which contributes to explain why Japanese wages have become less responsive to economic activity and labor demand.

the one of the other two categories

$$\frac{\partial w^d}{\partial x} \simeq \frac{\partial w^y}{\partial x} > \frac{\partial w^c}{\partial x}$$

This fourth stylized fact is consistent with the wages of employed workers being less volatile than the wage of workers transiting through unemployment (being old or young). Indeed, wages adjust either during hires (Pissarides (2009)) or when workers move to a new job within their firm (see Moscarini and Postel-Vinay (2017) for a recent contribution and references).

We now use this simple representation to characterize the effects of an increase of labor supply of the old. We assume this increase results from an evolution that is exogenous to the labor market, such as the ageing of baby-boomers and the reforms of pension reforms. We next present simple results about change in the participation rates, following the previous assumptions. The simple derivations are provided in Appendix

1. The increase in the participation rate of discontinuous old workers decreases average wage (d_t increases keeping the share of continuous-career workers constant c_t) : $\frac{\partial w_t^m}{\partial d_t} < 0$

2. An increase in the participation of old continuous worker has an ambiguous effect on aggregate wages. The composition effect, given that they enjoy higher level of wages, is positive. But the labor supply effect on the wages of the other two categories of workers is negative. $\frac{\partial w_t^m}{\partial c_t} > 0$ or $\frac{\partial w_t^m}{\partial c_t} < 0$

3. Wages react more to the business cycle when the participation rate of discontinuous old workers increases (d_t increases, c_t being constant): $\frac{\partial^2 w_t^m}{\partial d_t \partial x_{tt}} > 0$ and less when the proportion of continuous old workers increases.

Altogether, the ageing of the population and the increase in the labor supply of older workers have ambiguous effects on the level of wages and the slope of the wage reaction to labor demand. The effects on the level and the slope should however depend on the relative increases in the labor supply of discontinuous and continuous old workers and whether the increase in the participation of older workers is mainly an increase in labor supply or an increase in labor demand. We therefore estimate in the data which of the effects dominate both on the level of wages and on the slope of the Phillips curve.

In the next section, we estimate which one of these effects dominate in wage Philipps curves that include data on the ageing of the labor force across OECD countries.

3 Data

We provide estimates at both the national level and the regional level. We assembled annual data on wage inflation, CPI inflation, labor productivity, the rate of unemployment and the participation to labor markets for 19 OECD countries: the US, Japan, Germany, France, the UK, Italy, Canada, Australia, Spain, the Netherlands, Belgium, Austria, Finland, Denmark, Norway, Sweden, Switzerland and Portugal and Ireland. Our panel is balanced from 1996 to 2016.

To better identify the mechanisms, we also use a database of 203 regions for the 1999 to 2016 period. The data are available for 19 regions in Spain, 16 in Germany, 12 in the Netherlands, 9 in France, Austria and 7 in Portugal. The data are collected from Eurostat and national statistical agencies to obtain some of the regional inflation indices. Altogether, we have 2706 observations of regional wage inflation rates.

We provide an overview of the trend using national data. In particular price and wage inflation and labor market variables are plotted in Figure 1 to 4 for G7 countries plus Spain and the Netherlands.

First, inflation (CPI, wage inflation and nominal unit labor cost defined as wage inflation minus the growth rate of labor productivity) show contrasted patterns across countries (Figure 1). In the US, France, the UK, Italy, Spain and the Netherland, inflation tend to be inferior post 2010 than in the decade before the great recession. We observe the opposite trend in Germany and and Japan, two countries where inflation remains however subdued. Figure 2 shows the unemployment rates for total population and for workers above 55. We observe that the two rates are highly correlated in most countries. Figure 3 shows the dramatic increase in the participation rate of older workers in all countries. This is in sharp contrast with the stability of participation for workers aged 25 to 54 (Figure 4). However, the timing of changes in the participation rates is somewhat different across countries. Most of the increase takes place between 1996 and 2008 in the US, while in Germany and Austria it starts in 2003 and in Japan, we observe steps before 2000 and from 2008 to 2012 before a sharp increase thereafter. In other countries we observe a more steady increase of participation by elder workers from 1996 to 2016. However, even in countries where the increase is steady, the levels of participation differ. In contrast, the participation rate of workers aged 25 to 54 varies less and is more uniform across countries.

4 Estimation results

4.1 Country panel estimates of Wage Phillips curves

We report the panel estimates[6] of standard backward looking wage Phillips curves first for G7 countries (in Table 1), then for 8 "large" EA member states, EA8 thereafter (in Table 2) and finally for 19 OECD countries (in Table 3). As shown in the first column, wage inflation is highly responsive to its three traditional determinants: lagged CPI inflation, productivity and the unemployment rate. The T-stat of the unemployment rate is around 8 for the G7 or the EA8 and 12 for the panel of 19 OECD countries. The notion that wage inflation is not responding to labor market slack appears extremely unlikely. Of course, the sample we consider here, which includes the Great recession, is one with a high degree of co-movement between local labor market conditions and the global business cycle. Hence, some of the effects of the national unemployment rate may imbed the effects of a global slack à la Borio and Filardo (2007). However, while it may be difficult to disentangle the role of the global slack and the local one. Jasova, Moessner and Takats (2018) actually show that both domestic and global slack impact domestic inflation. Our estimates show that labor market slack influence wages which ever is the driver of this labor market slack.

Turning to the period after 2009, for which estimates are reported in the last column of Table 1, 2 and 3, the effects of the unemployment on wage inflation are still estimated to be negative. However, given the reduction of the degrees of freedom we have over these seven years, these effects are somewhat less precisely estimated, especially among G7 countries.

4.2 Does the participation of baby-boomers impact wage inflation?

The second column reports the panel estimates of a specification augmented with three additional variables:

1. the difference in the unemployment rates of two categories of workers, the ones aged 55 to 64 and the ones aged 25 to 54;

2. the rate of participation to the labor market; and,

3. the difference in the participation rates of workers aged 55 to 64 and the ones aged 25 to 54.

[6]The estimates reported here correspond to fixed effects regressions. Given the narrow cross section of the sample we also estimated the same equations with the Mean Group Estimators. Results, which are not reported for the sake of space, are very similar to the ones reported here.

Our aim is to assess whether the increased participation of older worker impact wages. However, we also include in the specification the participation rate of all age groups in order to control for the effects from forces that would drive overall participation rates. Following the same logic, we also assess whether changes in age composition of unemployed impact wages or the overall effects of the unemployment rate impact wages. Therefore we include both the overall unemployment and participation rates as well as differences of these rates above 55 and below 55 to test for a specific effect of the proportion of workers above 55 on wage developments.

Among these three additional variables, only the last one has an effect on wage inflation. An increased participation of older workers has a negative effect on wages either for the G7, the EA8 or across the OECD. We also note that the coefficient of unemployment is hardly affected by including these additional coefficients.

In columns 4 we include the yearly changes in the difference in participation rates instead of their level. This is to check that our result is not "spurious" given that participation of the elderly shows a trend in many countries while wage inflation rates decline for the sample period. With this specification, we still find a negative effect of participation on wage inflation. However this effect is no more statistically significant for the EA8 countries and for the OECD sample it is statistically significant only with the more parsimonious specification that does not include the overall participation rate not the differential in unemployment rates. All coefficients are less precisely estimated when we focus on the post 2009 sample. However, in the case of the G7 or the EA countries sample, we have only 47 and 56 observations respectively.

4.3 Regional panel estimates

We further investigate the role of labor market developments on wage inflation at the regional level. We put together data on wage inflation, participation of workers above 55, CPI inflation and the unemployment rate for 203 european regions. The data cover seventeen years from 2000 to 2016.

We regress the inflation of wage compensation of employees on the participation rate of old workers, lagged inflation and the unemployment rate with regional fixed effects to control for regional heterogeneity. We first perform the regression for the full sample and then dividing regions according to where they rank in the growth rate of the population. Results for the half of the regions where the population growth has been the fastest (slowest) is reported in column two (three). We want to account for a the risk of an omitted variable bias and more specifically for the risk that regions with low wage dynamics are also regions where young workers

migrate out of the regions. This could generate a correlation between lower wages and a higher participation workers due to a shrinking labor force. The regressions show that the increase in the participation rate of old workers has a significant and homogeneous negative effect of wage inflation for all groups.[7] In all regressions we find that the unemployment rate has the correct sign and is significant, with however a larger effect in regions where population grew less.

5 Conclusions

Altogether the results reported in this paper are reassuring about our understanding of recent labour market dynamics.

First, we observe major adjustments of labor supply in response to the ageing of the population. In this respect, the persistent call of central banks for reforms has been either anticipated or answered to by politicians, labor market institutions, employers and workers. This increase in participation implies that potential output should have increased. If the participation of 20% of the working population (population aged 55 to 64 over population aged 20 to 64) has nearly doubled, it means that aggregate output potential should increase as well. It would increase by roughly 10% if the productivity of older worker grows in line with the one of other workers. It should increase by less than 10% if the productivity of older workers is slower. It will in any case grow as long as the productivity growth of these older workers is not too negative.

Second, (wage) inflation remains very much driven by cyclical forces and therefore it can be influenced by monetary policies. This result should be taken into account by those who fear that the "Phillips curve" transmission of monetary policy to inflation is broken. Central banks who spur activity and employment will eventually harvest domestic wage inflation, and, in all likelihood, inflation of goods and services.

Third, it is not clear yet how high participation rates of older workers will go. We are probably undergoing a very long transition and we don't know when it will end. But as long as this transition implies a larger slack than measured by the unemployment rate, the economy operates below its "NAIRU" potential. Taking a broader perspective, it seems that unemployment has not been a comprehensive indicator of labor market slack.

[7] We also perform regressions controlling for total population, which generates the same outcome. The partition of the regions provide more intuitive validation of the effect.

References

Agbayani, C., B. Gasperini, J. Moore, N. Nanda, L. Patterson, and S. Wander (2016): "Literature review report : labor Market and DOL ? Funded Employment Assistance for Older Worker," *US Department of Labor*.

Auer, R., C. Borio, and A. Filardo (2017): "The globalisation of inflation: the growing importance of global value chains," *BIS Working paper*, (602).

Bank of japan (2018): "The Recent Increase in Labor Supply and Wage Development," *The Outlook for Economic Activity and Prices*.

Blanchard, O. (2017): "Should we Reject the Natural Rate Hypothesis?," *Journal of Economic Perspectives*, (Forthcoming).

Blanchard, O., E. Cerutti, and L. Summers (2015): "Inflation and activity: Two explorations and their monetary policy implications," *"Inflation and Unemployment in Europe" 2015, ECB Forum on central banking*.

Bobeica, E., E. Lis, C. Nickel, and Y. Sun (2017): "Demographics and Inflation," *ECB Working Paper*, 105(2006).

Borio, C., and A. Filardo (2007): "Globalisation and inflation: New cross-country evidence on the global determinants of domestic inflation," *BIS working paper*.

Cahuc, P., J.-O. Hairault, and C. Prost (2016): "L'emploi des séniors : un choix à éclairer et à personnaliser," *Conseil d'Analyse Economique*.

Casanova, M. (2013): "Revisiting the Hump-Shaped Wage Profile," *UCLA Working paper*.

Ciccarelli, M., and C. Osbat (2017): "Low inflation in the euro area, causes and consequences," *ECB Occasional paper series*.

Constancio, V. (2017): "Understanding and overcoming low inflation, remarks at the Conference on ?Understanding inflation: lessons from the past, lessons for the future??," *Frankfurt am Main, 21 and 22 September 2017*.

Hairault, J.-O., F. Langot, and T. Sopraseuth (2014): "Why is Old Workers Labor Market More Volatile? Unemployment fluctuations over the life-Cycle," *IZA Working paper*, 8076.

IMF (2017): "Recent Wage Dynamics in Advanced Economies: Drivers and Implications," *Chapter 2*.

Luke, H., and N. Duell (2017): "How will the demand for older workers be influenced by their wages and skills," *OECD contribution in Delivering higher effective retirement ages*.

Martina, J., R. Moessner, and E. Takáts (2018): "Domestic and global output gaps as inflation drivers: what does the Phillips curve tell?," *BIS Working Papers, Bank for International Settlements.*, (748).

Moscarini, G., and F. Postel-Vinay (2017): "The Job Ladder: Inflation vs. Reallocation," *Working paper*.

National Bank of Canada (2017): "The Phillips curve still holds !," *Special Report, Economics and Strategy*.

of Canada, N. B. (2018): "The Recent Increase in Labor Supply and Wage Developments: Box 1," *Outlook for Economic Activity*.

Pissarides, C. (2009): "A Law of Large Numbers for Large Economies," *Econometrica*, 77(5),

1339–1369.

Schmieder, J. F., T. Von Wachter, and S. Bender (2012): "The effects of extended unemployment insurance over the business cycle: Evidence from regression discontinuity estimates over 20 years," *The Quarterly Journal of Economics*, 127(2), 701–752.

Schwandt, H., and T. Von Wachter (2017): "Unlucky Cohorts: Earnings, Income and Mortality Effects from Entering the Labor Market in a Recession," *Working paper*.

Takats, E. (2010): "Ageing and Asset Prices," *BIS Working Paper*, (318).

Appendix

A Derivation of the results of the simple model

Proof of claim 1. On can compute the derivative

$$\frac{\partial w_t^m}{\partial d_t} = -\frac{1+g_t}{(1+g_t+c_t+d_t)^2}w^y - \frac{c_t}{(1+g_t+c_t+d_t)^2}w^c + \left(\frac{1}{1+g_t+c_t+d_t} - \frac{d_t}{(1+g_t+c_t+d_t)^2}\right)w^d$$

After some algebra

$$\frac{\partial w_t^m}{\partial d_t} = \frac{w^d - w_t^m}{1+g_t+c_t+d_t} < 0$$

The proof of the claim 2 stems from the fact that it is not possible to give a sign to the derivative $\frac{\partial w_t^m}{\partial c_t}$ in the general case. For the Proof of claim 3, one has

$$\frac{\partial^2 w_t^m}{\partial d_t \partial x_t} = = \frac{\frac{\partial}{\partial d_t}w^d - \frac{\partial}{\partial d_t}w_t^m}{1+g_t+c_t+d_t} - \frac{w^d - w_t^m}{(1+g_t+c_t+d_t)^2} = \frac{\frac{\partial w^d}{\partial d_t} - \frac{\partial w_t^m}{\partial d_t} - \frac{\partial w_t^m}{\partial d_t}}{1+g_t+c_t+d_t}$$

As $\frac{\partial w^d}{\partial x_t} \simeq \frac{\partial w^y}{\partial x_t} > \frac{\partial w^c}{\partial x_t}$, we get $\frac{\partial w^d}{\partial d_t} > \frac{\partial w_t^m}{\partial d_t}$. As $\frac{\partial w_t^m}{\partial d_t} < 0$, we have $\frac{\partial w^d}{\partial d_t} - \frac{\partial w_t^m}{\partial d_t} - \frac{\partial w_t^m}{\partial d_t} > 0$. As a consequence,

$$\frac{\partial^2 w_t^m}{\partial d_t \partial x_t} > 0$$

Tables and Figures

Table 1: Estimates of wage Phillips curves in a panel of G7 countries

	(1)	(2)	(3)	(4)	(5)
	1996-2016	1996-2016	1996-2016	1996-2016	2010-2016
Lagged CPI inflation	0.548***	0.459***	0.504***	0.532***	0.0656
	(6.62)	(5.23)	(5.97)	(6.49)	(0.50)
Labor productivity gr	0.573***	0.536***	0.541***	0.557***	0.290*
	(9.28)	(8.37)	(8.56)	(9.07)	(2.04)
Unemployment rate	-0.454***	-0.464***	-0.473***	-0.456***	-0.195
	(-8.20)	(-7.63)	(-8.52)	(-8.35)	(-1.81)
U. Rate diff. Ab. 55 - bel. 55		-0.156			
		(-1.48)			
Participation rate		0.0782			
		(1.13)			
P. Rate diff. Ab. 55 - bel. 55		-0.0591**	-0.0357*		-0.0195
		(-2.78)	(-2.08)		(-0.44)
dP. Rate diff. Ab. 55 - bel. 55				-0.179*	
				(-2.24)	
_cons	3.967***	-2.306	3.181***	4.123***	2.356
	(9.05)	(-0.50)	(5.53)	(9.41)	(1.66)
# countries	7	7	7	7	7
# observations	162	162	162	162	47

The dependent variable is wage inflation. Wages are measured as the compensation of empoyees. (T Stats).
All regressions include a country fixed effect.

Table 2: Estimates of wage Phillips curves in a panel of 8 "large" EA economies

	(1)	(2)	(3)	(4)	(5)
	1996-2016	1996-2016	1996-2016	1996-2016	2010-2016
Lagged CPI inflation	0.417***	0.335***	0.351***	0.417***	0.275
	(5.41)	(4.25)	(4.48)	(5.43)	(1.98)
Labor productivity gr	0.305***	0.263***	0.256***	0.300***	0.164
	(5.90)	(4.95)	(4.84)	(5.81)	(1.21)
Unemployment rate	-0.257***	-0.277***	-0.264***	-0.258***	-0.241*
	(-8.77)	(-9.14)	(-9.20)	(-8.84)	(-2.14)
		(1.04)			
U. Rate differential above 55 - below 55		-0.0918			
		(-1.73)			
Participation rate		0.0126			
		(0.48)			
P. Rate differential above 55 - below 55		-0.0347**	-0.0309**		-0.0180
		(-3.02)	(-2.99)		(-0.42)
dP. differential above 55 - below 55				-0.0803	
				(-1.56)	
_cons	3.362***	1.490	2.345***	3.442***	2.656
	(10.19)	(0.81)	(5.01)	(10.36)	(1.34)
# countries	8	8	8	8	8
# observations	172	172	172	172	56

The dependent variable is wage inflation. Wages are measured as the compensation of empoyees. (T Stats).

All regressions include a country fixed effect.

Countries included in the sample: Germany, France, Italy, Spain, Netherlands, Austria, Belgium and Finland.

Table 3: Estimates of wage Phillips curves in a panel of 19 OECD countries

	(1)	(2)	(3)	(4)	(5)
	1996-2016	1996-2016	1996-2016	1996-2016	2010-2016
Lagged CPI inflation	0.417***	0.339***	0.340***	0.412***	0.117
	(7.84)	(6.34)	(6.41)	(7.78)	(1.14)
Labor productivity gr	0.229***	0.194***	0.194***	0.229***	0.0687
	(6.48)	(5.57)	(5.62)	(6.51)	(1.40)
Unemployment rate	-0.378***	-0.392***	-0.394***	-0.381***	-0.274**
	(-12.99)	(-13.08)	(-13.96)	(-13.14)	(-3.13)
U. Rate differential, above 55 - below 55		-0.000811			
		(-0.01)			
Participation rate		0.00812			
		(0.26)			
P. Rate differential above 55 - below 55		-0.0666***	-0.0654***		-0.0494
		(-5.18)	(-5.63)		(-1.29)
dP. Rate differential above 55 - below 55				-0.126*	
				(-2.26)	
_cons	4.289***	2.041	2.595***	4.394***	2.392
	(16.46)	(0.94)	(6.62)	(16.68)	(1.95)
# countries	19	19	19	19	19
# observations	425	425	425	425	130

The dependent variable is wage inflation. Wages are measured as the compensation of empoyees. (T Stats).

All regressions include a country fixed effect.

Countries included in the sample: G7 countries, Spain, Netherlands, Austria, Belgium and Finland, Australia, Denmark, Norway, Sweden, Switzerland and Ireland and Portugal.

Table 4. Estimates of wage Phillips curves in 203 regions of 24 countries (2000-2016)

	Regions / growth of population		
	All	fastest	slowest
Participation rate (55+)	-0.318***	-0.264***	-0.372***
	(-5.15)	(-3.77)	(-3.77)
Lagged CPI inflation	0.146*	-0.109	0.160*
	(2.42)	(-0.76)	(1.97)
Unemployment Rate	-0.505***	-0.318***	-0.731***
	(-8.66)	(-6.49)	(-6.21)
#observations	2706	1404	1302

The dependant varialbe is wage inflation. Wages are measured as the compensation of employees. (T-stats)

Estimates are reported for all regions, the half the the region whre population has grown the fastest between 2000 and 2016 and the half of the regions where the growth of population has been the slowest.

All regressions include a regional fixed effect.

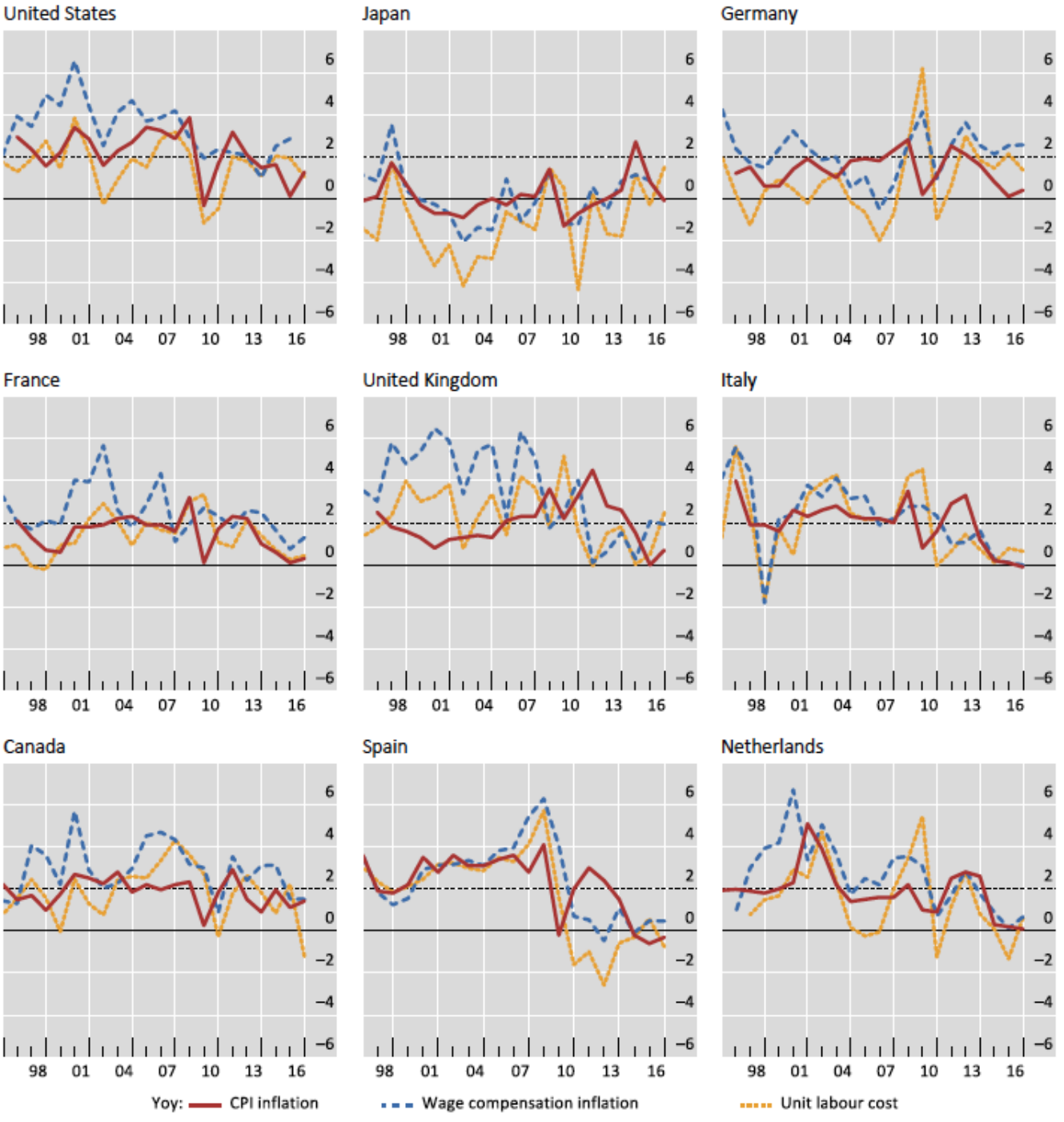
Country (#regions): Italy (21), Spain (19), Germany (16), Poland (16), Greece (13), Netherlands (12), UK (12), Belgium (11), France (9), Austria (9), Czech Republic (8), Romania (8), Sweden (8), Hungary (7), Portugal (7), Bulgaria (6), Denmark (5), Finland (5), Slovakia (2), Croatia (2), Slovenia, Latvia, Luxembourg, Lithuania (1 each)

Source: Eurostat, National Statistics offices (regional CPI for Spain and Portugal), Stata, Banque de France

Inflation and productivity

In per cent

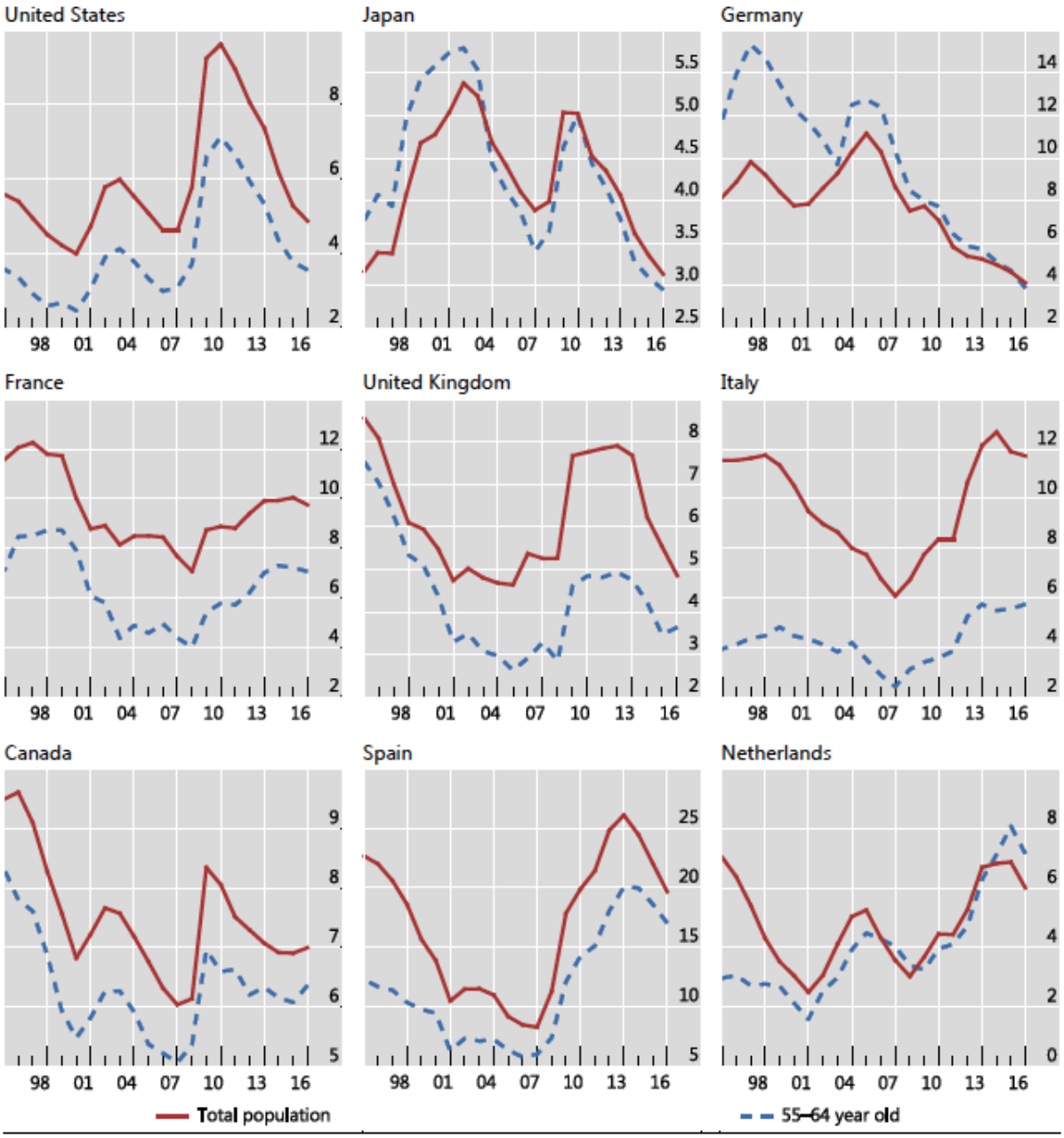
Figure 1



Unemployment rates

In per cent of the active population

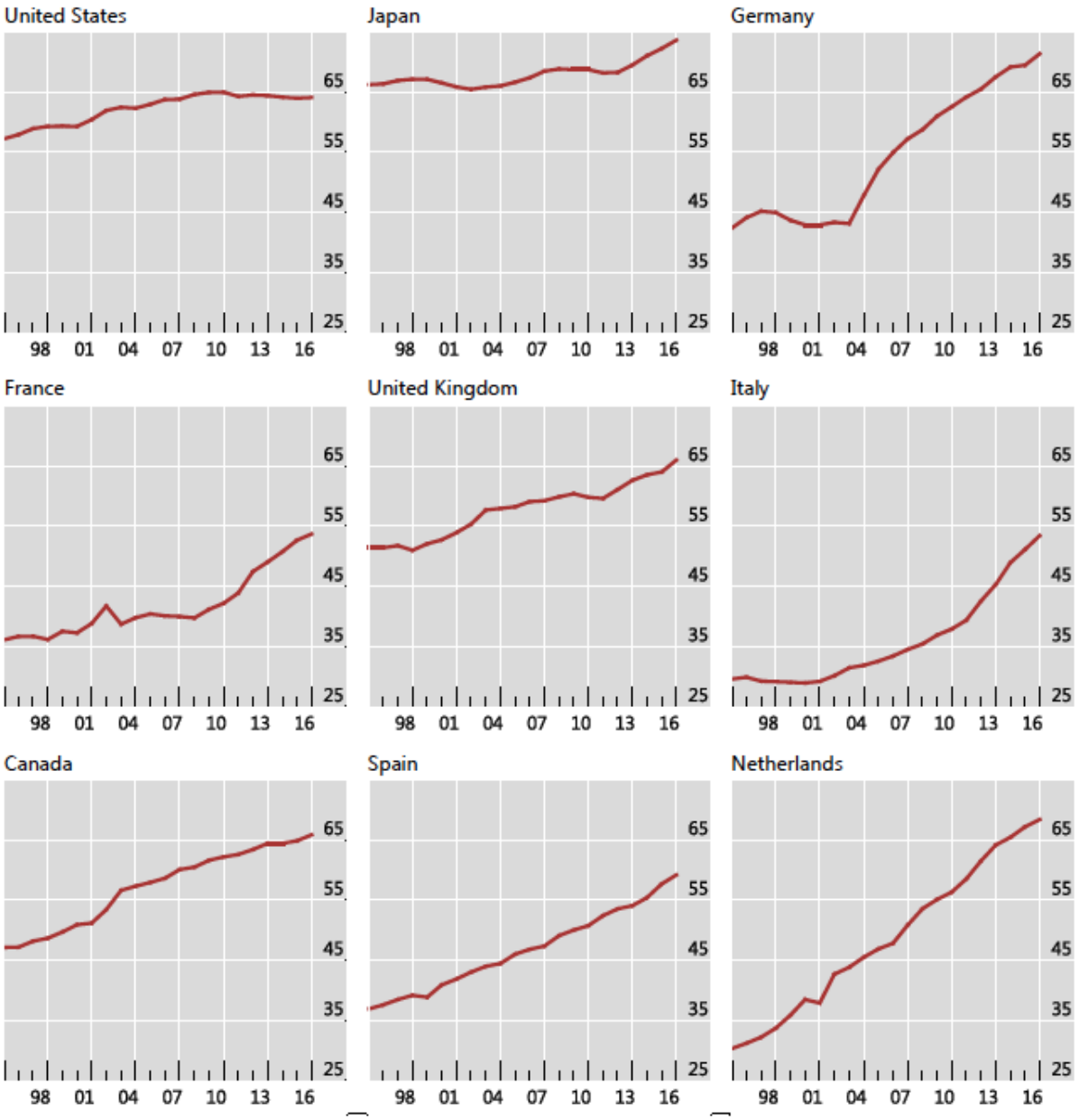
Figure 2



Participation rates: 55-64

In per cent of the population

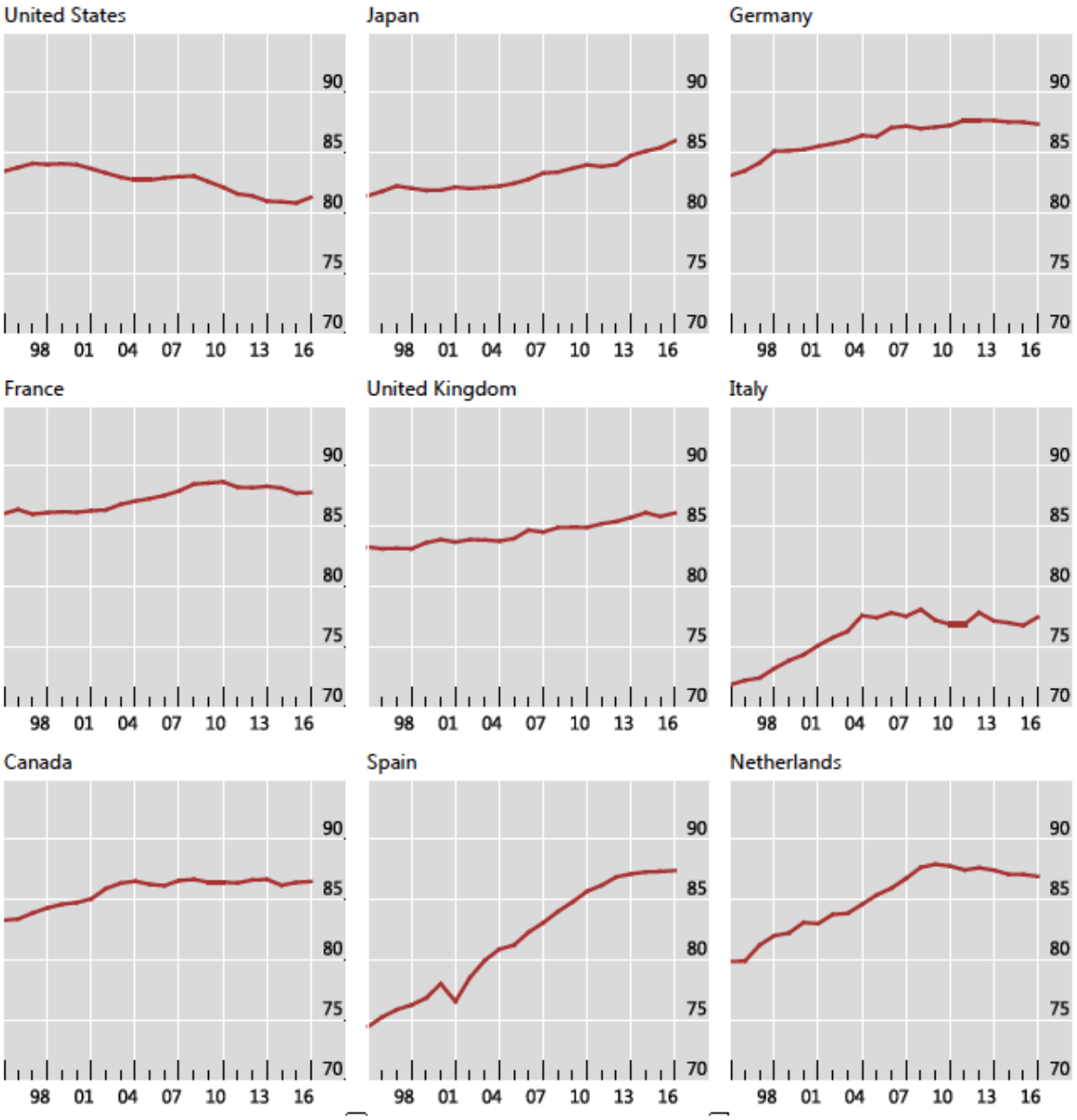
Figure 3



Participation rates: 25-54

In per cent of the population

Figure 4



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